A NEW SERIES OF SEDIMENT COLLECTORS FOR MONITORING TRUE BEDLOAD

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ABSTRACT

Streamside Systems LLC offers a bedload monitoring collector with variable mesh screening to collect targeted sizes of bedload sediment. Prototypes have been tested for continuous operation (3 to 5-month periods) for sand to medium gravel moving as bedload. The Streamside collectors sample true bedload, and avoid the collection of suspended sediment and organic matter. Bedload net samplers such as the Helley-Smith, which block a partial cross-section of the water column, can become blocked by the inclusion of organic matter, and are biased by including suspended sediments (from near the bottom of the stream, where suspended sediment concentrations are highest). In low-gradient streams, the Streamside collectors are pumped out, and can easily be back flushed or "zeroed". A siphon removal system will work continuously with a localized drop adequate to pull 20 to 25 gpm through the collector with a 2-inch hose. The outlet hose allows samples to be collected safely from the shoreline, even under high flow conditions, and for any desired sample period (seconds to months).

INTRODUCTION

Sedimentation is generally identified as the leading water quality problem in the United States. Streamside Systems LLC (Findlay, Ohio) was formed to research, design, and market equipment to aid in the prevention of sediment impacts to surface waters, and to restore sediment-impacted aquatic habitats. One series of products was designed to remove targeted sizes of sediments (generally sand and finer) as they move downstream as bedload. These collectors are passive, noninvasive, and scalable to any size stream or river. As a new, best available technology (BAT) alternative to dredging, the collectors can **avoid** the common adverse impacts of dredging, such as:

- Habitat damage via unselective removal of gravel and cobble
- Biological damage via removal of fish eggs, invertebrates, and organic matter
- Resuspension of sediment-associated contaminants
- Reduced water quality and increased turbidity due to substrate disruption, and
- Morphological damage that can lead to headcutting

A wide variety of applications exist for this new type of passive bedload sediment collector, including:

- Habitat improvement for fish spawning or for endangered mussels, through selective removal of harmful fine sediments, an increase in the substrate median particle size (D50), and reduced embeddedness
- Reduction in pond and reservoir sedimentation, by removal of bedload at the mouths of tributary streams
- Solution to "hungry waters" below dams, by collecting the bedload in tributary streams, bypassing the reservoir, and reintroducing the sediment below the dam
- Selective removal of a clean-washed commercial product (sand), with no increase in turbidity over ambient, while improving habitat
- Reduction in water treatment costs for industrial, municipal, and agricultural water users
- Prevention of downstream sediment impacts below dam-removal projects, below logging operations, and at stream crossings for roads and utilities
- Maintenance of navigation channel depth in major rivers, and sediment bypass systems for coastal inlets
- Supplying clean, sorted sand for beach nourishment programs
- Restoration of aggrading channels or individual pools by installing collectors as grade control structures that remove excess sediments, and
- Collecting bedload data to develop watershed sediment budgets; to develop sediment TMDL's; to measure nonpoint source sediment impacts throughout a watershed; and to collect bedload data to document damages, identify sources, and assess liability for sediment impacts.

INSTALLATION AND OPERATION

Bedload sampling is the specific application of Streamside collectors to be addressed here. The portable collector is of stainless steel construction and is dug into the streambed and anchored. As bedload sediments move downstream over the collector, they drop through the screen into a hopper and are continuously removed by siphon suction or by pump-out. A computerized controller can be added to electric systems, to pump on a timed cycle or with respect to stream stage or discharge. Maximum particle sizes sampled depend on the width of screen slotting used, the size of the collector, the hopper capacity, and the output hose diameter. Prototype collectors that have been used for three to five month periods of continuous operation had screen slots of 5mm, 0.5 inch, or 1.0 inch, with a two-inch outlet hose. Another Streamside bedload sampler design uses three separate collection chambers, with screening slots of 2mm, 8mm, and 64mm.

The collectors are scalable to any size stream, and multiple units (e.g., 10-ton pre-cast concrete collectors, with large capacity urethane hopper assemblies) can be linked together to completely cross major rivers. The collectors can be constructed with or without sidewalls. For small streams, a two-foot wide sidewall collector can use supplemental wing walls to channel and collect 100% bedload (of the screen-selected sizes) from a four to six-foot wide channel. Collectors without sidewalls can be emplaced adjacent to each other, or small units can be installed at various locations on a cross-section.

Streamside collectors measure the sediments that move along the stream bottom and fall into the hopper. Leaf litter, invertebrates, eggs, and other organic matter all pass over the collector

unaffected. When a collector without sidewalls is dug into the streambed, it is virtually snag-free, and passively removes the targeted sediments on a continuous basis. Sediment samples can be collected in a large bin or truck bed or sediment basin while the equipment is unattended, and manual samples can be safely taken over any time interval (from seconds to months) or any hydrograph category (rising, falling, or flat). Small, portable collectors can be used as bedload subsampling devices, or collectors can be sized to target the entire stream width. Streamside Systems offers 10 and 20-ton pre-cast concrete collectors to commercial sand mining operations, that can target 100% of bedload sand transport in large rivers; this can offer invaluable data on continuous bedload transport rates that have never before been available for major rivers. The flexibility of allowing extremely long-term and large volume samples, greatly reduces the variability and subsampling error inherent in bedload sampling with alternative methods.

DISCUSSION

The numerous potential applications for Streamside Systems collectors are mentioned in this paper because they define the various interest groups that may fund and operate the sediment removal installations, thereby providing bedload data on a wide range of stream types and stream sizes, as a side benefit and at no cost to the "bedload community". Adoption of Streamside Systems collectors as a Best Available Technology (BAT) alternative to dredging for instream sand mining operations, would give the aggregate industry a better product at a lower cost, while eliminating significant environmental impacts and positively improving instream habitat, and also providing some of the best available bedload transport data for sand-bed streams. Many sites hold the potential to "turn the pollutant into a commercial product", while restoring sediment-impacted streams, and providing a funding source for riparian restoration, for conservation easements, and for monitoring programs. Clearly, cooperation and cofunding needs to be encouraged among the community of "sediment stakeholders" in a watershed.

Accuracy is a major issue yet to be addressed. We have conducted simple measurements above and below Streamside collectors, with a Helley-Smith sampler. Results showed that Streamside collectors were 94% efficient. Since our collectors capture sediments that are moving along the stream bottom (i.e., bedload) and drop into the hopper, and since the Helley-Smith uses a net that sieves a cross-section of the water column at the bottom of the stream (where suspended sediment concentrations are highest), it is perhaps more logical to say that Streamside collectors capture 100% of the "true bedload", and can be used to estimate the degree of over sampling bias from water column nets that capture suspended sediment plus bedload. We find it difficult to consider a net clogged with loads of organic matter to be a "bedload sample". Perhaps a new working definition of "bedload" is in order.

Streamside Systems collectors appear to hold great promise, particularly for measuring sand and fine gravel transport. We have not yet built or tested the collectors for coarse gravel or cobble, although they should be scalable to any desired particle sizes. Several studies are currently underway regarding trout habitat improvement, morphological impacts, and macroinvertebrate recolonization studies, but much research remains to be done.